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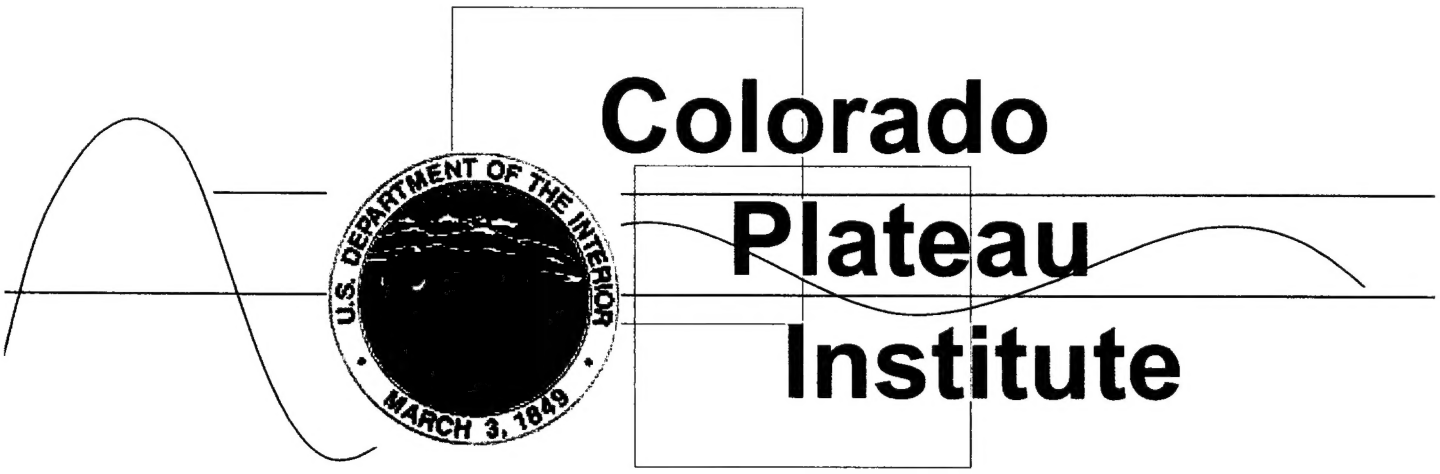

Colorado Plateau Institute

Masters of Architecture Terminal Project
College of Architecture
University of Nebraska-Lincoln

Graduate study of Brian J. Ballweg
Mentorship by Prof. Sharon Baum-Kuska
7 May 2003

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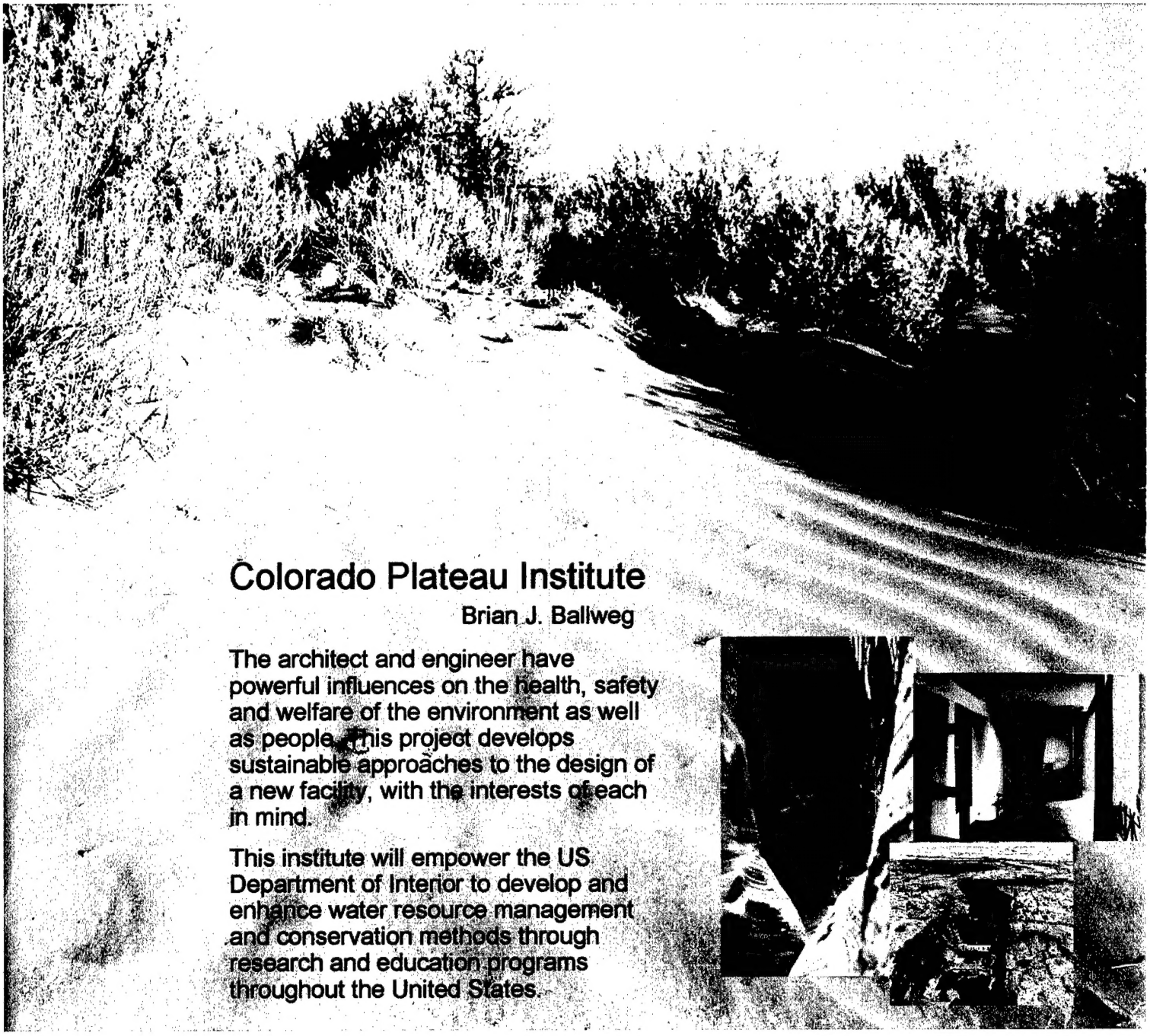

Colorado Plateau Institute

Brian J. Ballweg

The architect and engineer have powerful influences on the health, safety and welfare of the environment as well as people. This project develops sustainable approaches to the design of a new facility, with the interests of each in mind.

This institute will empower the US Department of Interior to develop and enhance water resource management and conservation methods through research and education programs throughout the United States.

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Colorado Plateau Institute

United States Department of Interior

Figure 1-1: The Colorado Plateau region in the southwestern United States. The Colorado River drains an area larger than France, and brings life to over 21 million people.

Figure 1-2: The Colorado Plateau is also home to the sandstone canyonlands regions of Utah and Arizona.

Table of Contents

May 2003

Colorado Plateau Institute

United States Department of Interior

Figure 1-1: The Colorado River cuts through deep sandstone canyons, forming a unique environment.

Figure 1-2: Glen Canyon Dam under construction in 1962.

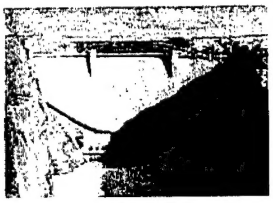


Figure 1-3: Glen Canyon Dam seen today.

Introduction

Life is drawn together in lands of little water. It is no different in the slickrock country of the Colorado Plateau. Glen Canyon Dam was built in seven years, transforming a river while submerging beautiful canyons, labyrinths, and temples that took millions of years to construct. The town of Page emerged from the controversy, and is the site of a research institute that studies water-resource issues that result from Man's desire for A Garden in the Desert.

The Apollo space program, the Eisenhower Interstate System, Colorado River Storage Project. All are icons of an era when America was fighting a Cold War and locked in an ideological struggle with another nuclear superpower. America went to great lengths to emerge the victor, and sacrificed much in the process. The Colorado River and a countless number of canyons became one of those sacrifices.

Since 1996, the Department of the Interior has worked to manage the resources of the Colorado River in a range of alternative methods. One method involves the controlled flooding of the river through the Grand Canyon National Park. Sedimentation that has been trapped behind the Glen Canyon Dam is being released to restore sandbars, habitat for endangered species, and downstream riparian vegetation.

Issues

The slickrock country of the Colorado Plateau has a history as rich and colorful as the rock that forms its canyons and mesas. Life is drawn together in lands of little water, as Pueblo, The Diné, Spanish, Mormon and other inhabitants of this arid region can testify. In small, sustainable communities, pockets of civilization flourish, and a collage of architectural styles have developed.

Today, more people than ever are drawn to the beauty of the Southwest. Demands on existing water resources are ever increasing, as contemporary society destructively creates the garden in the desert. As a result, the Colorado Plateau has lost some of its most brilliant canyons and its mightiest river. Increasingly severe competition for whatever small quantities of water remain in the Colorado River keeps the plateau tied up in litigation and controversy. Water projects must now undergo thorough environmental-impact studies in accordance with federal environmental protection legislation. In addition, there is mounting political pressure to restore the Colorado River to its original state, especially through the Grand Canyon.

Glen Canyon Dam has controlled the flow of Colorado River water through Grand Canyon since completion in 1963. By changing the flow of water and sediment downstream, the dam has caused numerous changes, including a decline in the number and size of sand bars along the river in Grand Canyon National Park. Sand bars

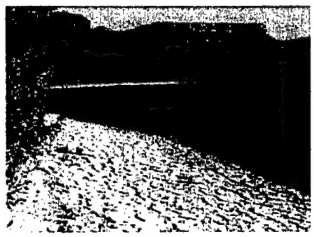


Figure 2-1: One of the most endangered rivers in the world, the Colorado is known as a 'deficit river'.

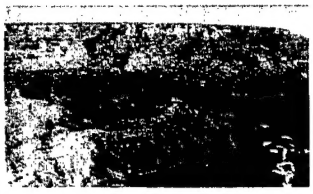


Figure 2-2: The Grand Canyon is carved by the Colorado River.

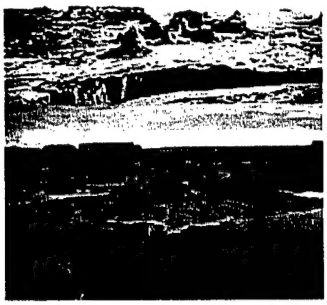


Figure 2-3: Before and after Lake Powell.

Figure 3-1: The Colorado Plateau region in the southwestern United States. The Colorado River drains an area larger than France, and brings life to over 21 million people.

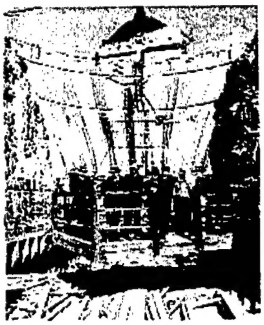


Figure 3-2: The Colorado Plateau is also home to the sandstone canyonlands regions of Utah and Arizona.

and banks are essential components of the Colorado River ecosystem and were distinctive features of the pre-dam landscape. They create terrestrial habitat for riparian vegetation and associated fauna, and backwater channels used as habitat by native fish. Bars are used by boaters and other park visitors, and some of them help preserve archeological resources. Because of the sand bars' importance, their restoration and maintenance have been a high priority for programs established by the Department of Interior (DOI)'s Bureau of Reclamation to assess Glen Canyon Dam's effect on downstream resources and to make recommendations for dam operations that will better protect those resources. The most recent such program was established in 1996, as the Glen Canyon Adaptive Management Program.

As dam and water resource investigations in the Colorado Plateau continue to develop, it will be essential to have access to a regional laboratory and support facilities that aid researchers investigating ecological systems that exist before and after reclamation. The emphasis of these research activities changes through time, reflecting the emergence of promising new areas of inquiry and the demand for new tools and techniques with which to address water-resource issues. The Institute proposed in this terminal project will provide the facilities for this type of concept.

Objectives

The relationship between people and environment is a key concept of my terminal project. The architect and engineer have powerful influences on how contemporary society interacts with the environment, whether it is physical control (as in the Colorado river) or a delicate balance (sustainable design).

Mission Statement

To develop and enhance water resource management and conservation methods through research and educational programs.

Strategic Plan

Support of research initiatives and technology development that promote environmentally responsible construction and development methods in arid climates. Through this Institute, the Department of Interior will:

1. Diversify economic base
2. Become focal point for both government and private research programs
3. Preserve and help to facilitate eco-tourism

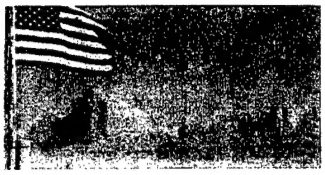


Figure 4-1: The Colorado Plateau region in the southwestern United States. The Colorado River drains an area larger than France, and brings life to over 21 million people.

Figure 4-2: The Colorado Plateau is also home to the sandstone canyonlands regions of Utah and Arizona.

Figure 5-1: The University of New Mexico main branch library

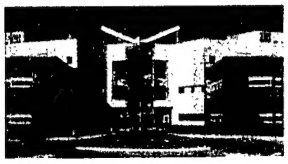


Figure 5-2: The Peter Kiewit Institute

Precedents Study

The Institute will be a mixed-use facility, serving different clients and customers with varying objectives. In the programming of the facility, multiple existing precedents were examined.

University of New Mexico main library (Fig 5-1)
The campus library is constructed using both traditional and contemporary construction methods. The building also utilizes passive cooling methods, avoiding gains due to solar radiation through shading and reflective barriers and heat transfer through the envelope.

The Peter Kiewit Institute (Fig 5-2)
A joint program between private and educational sources, students from the University of Nebraska at Omaha's College of Information Science and Technology (IS&T) and the University of Nebraska-Lincoln's College of Engineering and Technology (E&T) explore a variety of degrees while they work closely together in courses and labs in both colleges. Specialized labs allow students to learn about lighting, heating and cooling, computer-aided manufacturing, imaging and robotics. The Kiewit Institute provides a campus setting in a laboratory and research facility.

The Kiewit Institute was designed in 1996 in a vacated race and sports track in central Omaha. The project has helped to revitalize and rehabilitate an area of Omaha that had degenerated the surrounding communities both economically and aesthetically.

Zion National Park Visitors Center (Fig 6-1)
The National Park Service constructed the state-of-the-art Visitors Center in 1998. The Visitor Center is an award-winning example of sustainable design. The Denver Service Center, working with the U.S. Department of Energy's National Renewable Energy Laboratory, created a sustainable building that incorporates the area's natural features and energy-efficient building concepts into an attractive design that saves energy and operating expenses while protecting the environment. The facility combines a wide range of basic sustainable designs and technologies. The facility is expecting 80% energy-savings over conventional visitor centers. The park is expected to save $16,000 per year in energy costs.

Figure 6-1: Zion National Park Visitors Center

The Watchtower
Designed and constructed in 1932 by architect Mary Colter, this structure combined native American architecture and contemporary building technology of the period. Before constructing the Watchtower at Desert View (Fig 6-2) she visited several native American sites in the southwest to examine first-hand the construction techniques that the natives used to construct their own towers.

Figure 6-2: The Watchtower, Grand Canyon National Park

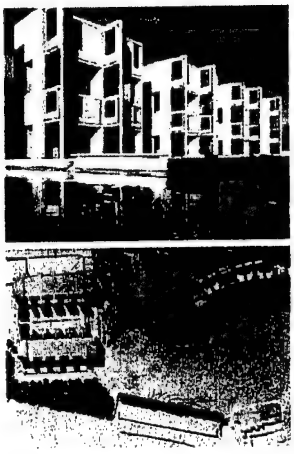


Figure 7-1: The Salk Institute

Figure 7-2: The DeFelice Marine Center on the Mississippi River delta

Salk Institute for Biological Studies (Fig 7-1)
The laboratory design by Louis Kahn was an open plan, flexible space that has been able to adapt to new research programs in biological and medical sciences. The 65' x 245' laboratories are, "characterized as the architecture of air cleanliness and area adjustability," stated Kahn. The central court (Fig 9-2) opens to ocean views, inspiring human endeavor and achievement.

The DeFelice Marine Center (Fig 7-2)
Located in Cocodrie, LA, on the Mississippi river delta and Gulf of Mexico, is the nerve center for several field research programs located throughout the surrounding area. The center is open to public visitors, bird watchers, and enthusiasts as well as students and scientists involved in a variety of field projects. Completed in 1986, the center is a 75,000 SF laboratory, classroom, library, office, and dormitory spaces.

The center is sponsored by a consortium of educational institutions known as Louisiana Universities Marine Consortium (LUMCON), and has expanded its role beyond a regional study of coastal water ecological systems to a study of hydrological research of river and coastal waters throughout the world

USGS Las Vegas Station
A site visit in March to the US Geological Survey field office in Las Vegas was the initial phase of addressing a user need studies, environmental psychology, and environmental design of laboratory. This lab is engaged in issues of water supply, flood hazards, erosion, and water chemistry in an area that is a large Colorado River drainage basin.

Anastazi and Southwestern Cultures (Fig 8-1)
An analysis conducted during the Summer semester examined sustainable design specific to southwestern United States. This analysis includes Native American architecture, early pioneer and Mormon settlement in the region, and an assessment of environmental quality and performance in contemporary design.

Soda Springs Desert Study Center (Fig 8-2)
The Desert Studies Center, field station of the California State University (CSU), provides opportunity for individuals and groups to conduct research, receive instruction and experience the desert environment. Established in 1976 under a cooperative management agreement with the Bureau of Land Management, the Center is operated for the CSU by the California Desert Studies Consortium.

LDS Institute of Religion
The Latter Day Saints Institute of Religion in Lincoln, Nebraska (Fig 8-3) is an example of an adaptive use facility. The Institute of Religion has two large classrooms and auditorium, exhibit area, student lounge and study areas, resource center, as well as support and administration spaces, including office, print and resource room, storage, and restrooms.

Figure 8-1: Petroglyphs of Anastazi origin dating to the twelfth century, now under Lake Powell.

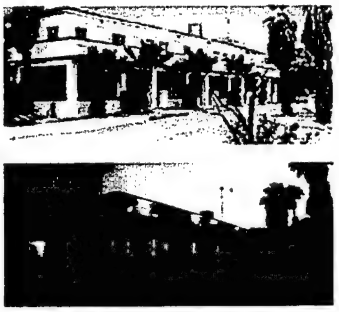


Figure 8-2: Soda Springs Desert Study Center in Baker, CA.

Figure 8-3: LDS Institute of Religion

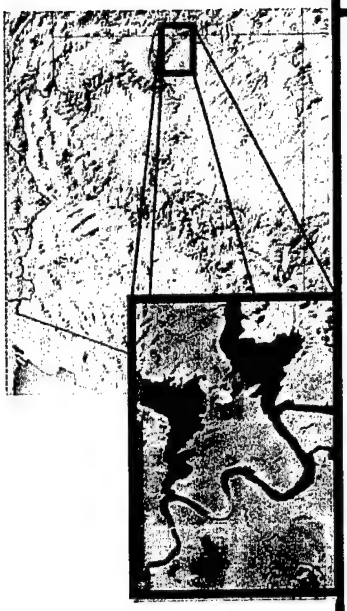


Figure 9-1: Arial view of Page

Figure 9-2: Construction of Glen Canyon Dam, 1956.

The Site

Page, Arizona
The Institute is located in the city of Page, Arizona. Page is located in northern Arizona near the shore of Lake Powell (Fig 9-1). The city is known as the Gateway to Lake Powell and provides a convenient location to stage trips and other destinations in the scenic country of northern Arizona and southern Utah. The incorporated area of the community consists of 16.56 square miles of land. The city is bounded by the Glen Canyon National Recreation Area to the north and west, and the Navajo Reservation to the east and south.

The city of Page was established in 1956 by the US Bureau of Reclamation to house construction workers building the Glen Canyon Dam (Fig 9-2) and hydroelectric power project. Early in its history, the city experienced some "boom and bust" periods tied to large construction projects that include Glen Canyon Dam and the Navajo Generating Station.

In recent years, the city has focused its development efforts on diversifying the economy to include tourism, recreation and the hospitality industry. The city has constructed a sports complex, an 18-hole championship golf course and portions of a trail system around Manson Mesa. Recent educational improvements include the construction of a new elementary and middle school and renovations to existing elementary and high schools. Coconino Community College constructed a new college campus in 1996 on Lake Powell Boulevard (BRW, Inc. and Sunregion Associates, Inc., Page General Plan Update, pg. 1-1).

Existing Setting

The existing land use pattern in the city of Page is characterized by large open spaces surrounding the community, and a fairly compact, highly zoned development pattern in the development. Planning was initially conceived by the Bureau of Reclamation to serve workers at Glen Canyon Dam. The city government has had a tremendous influence on the location and growth of the city based on the fact that they are the major landowner in the city. According to the 1996 General Plan update, the city is approximately 4.86 square miles of urban development, and the extremely limited land constraints on Manson Mesa will compel the city to develop off-mesa areas (Fig 10-1).

Population

The 1990 population of Page was 6,598. By 1995, population of the city was estimated at 8,162 persons, and is projected to be 11,652 by 2015. Over the 25 year period, the housing stock is expected to expand by approximately 52 percent.

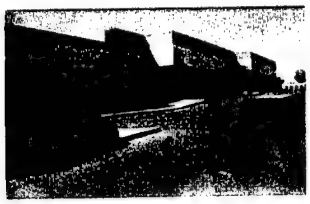
Demographics

The median annual income per household for Coconino county is $29,341. Many retired elderly and government employees located some distances from Page make up a large part of Coconino county's population. Page and the surrounding area has had a 40.2% population increase since 1990, growing at an average of 6.8% per year, according to the Arizona Department of Commerce. The community today is small and dispersed, with surrounding small housing developments and a growing industrial and manufacturing base.

Figure 10-1: Aerial view of Manson Mesa

Figure 10-2: View of Page and Manson Mesa from the north.

Figure 10-3: View of Wahweap Marina on Lake Powell.



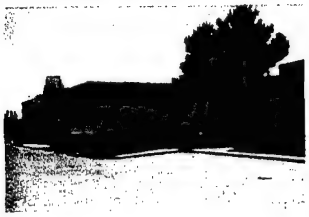
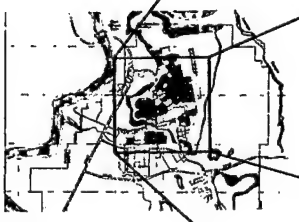


Figure 11-1: View of Page Plaza shopping Center.



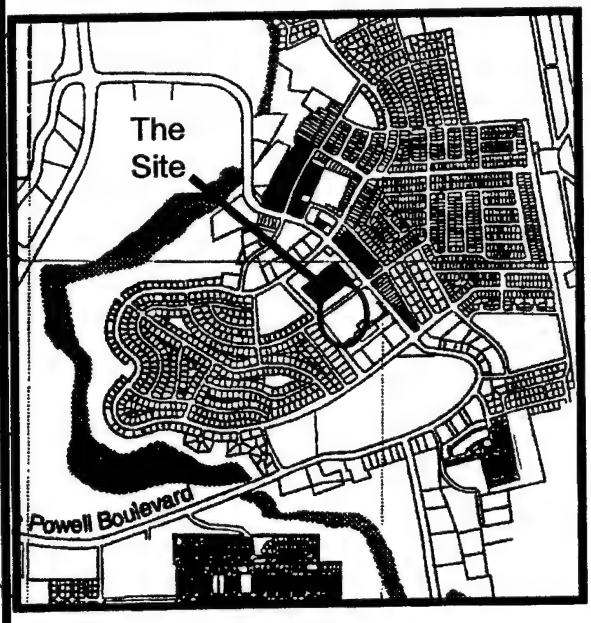


Figure 11-2: The site.

Elevation

Located on Manson Mesa, Page is at an elevation of 4310' above sea level.

Existing Facilities

The site is located in the Page Plaza shopping center. The existing facilities include a 19,000 SF and 14,000 SF open plan facility, concrete and steel construction (Fig 11-1 and 2). Currently, the vacant facilities are for lease by DSL Corporation of Northridge, CA.

Design Considerations

Wind load 80 MPH

Seismic Zone 2B

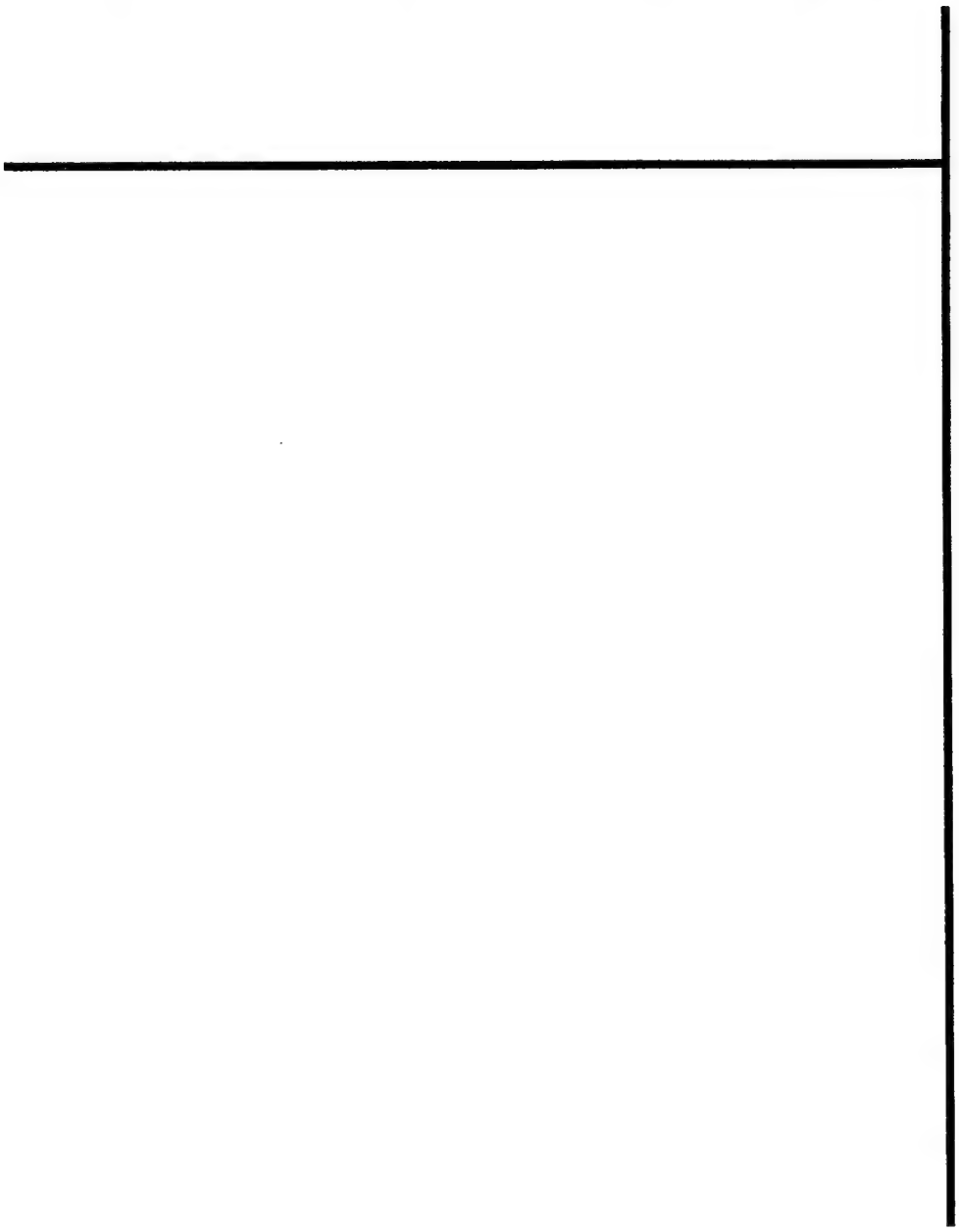
Frost depth 18 inches

Snow load 20 PSF. No reduction.

Roof drain sizing per 3" per hour rainfall if flat roof system.

Masonry buildings are considered engineered buildings.

Provide calculations for lateral and other loads and connections, or consult with the Building Department for design information.



Colorado Plateau Institute

United States Department of Interior

Figure 13-1: Map of the Colorado Plateau

Figure 13-2: Digital topographical map of Arizona

Environmental Survey

Table of Contents

Climate

The climate of the project site is typically dry and warm climate. A survey of the site revealed no areas of fog and frost retention in areas along the main branch and tributaries of the Colorado River. Snow and ice retention was light from October to April. Due to the dry climate, the design criteria for snow loads will be minimal. Below is a chart that provides the average monthly rainfall amounts for Page, AZ:

Average Monthly Temperature

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean Max. (°F)	42	48	61	69	84	93	95	93	88	75	59	43	**71**
Mean Min. (°F)	28	31	40	46	57	64	69	68	62	50	39	26	**48**

The average daily temperature is also typical of a warm, dry desert climate. The spring and fall are very moderate, with a short winter temperature decline. Below is a chart of the average monthly temperatures:

Average Monthly Precipitation (Fig 14-1)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Precipitation (in.)	.88	.74	.66	.24	.12	.66	.83	.90	.20	.02	.14	.28	**5.67**

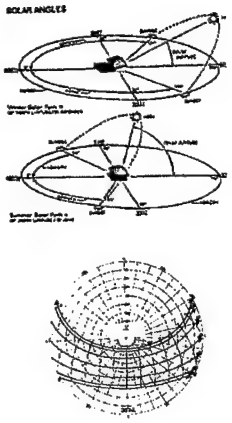


Figure 14-1: Solar diagrams

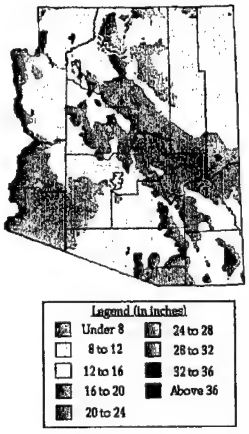


Figure 14-2: Map of average yearly precipitation for Arizona.

Figure 15-1: Soils map

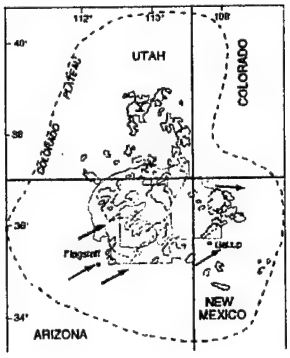


Figure 15-2: Areas of drift potential

Geology and Pedology

Derived From
U.S. Geological Survey, Misc. Geologic Investigations Map I-464
Reconnaissance Geologic Map of the North Half of the Arizona Quadrangle, last updated in 1997.

The following geological formations are found within the project site.

Jgc = Mesozoic Units. Glen Canyon Group. This early Jurassic geology includes Navajo Sandstone, Kayenta and Moenave Formations, and the Wingate Sandstone groups (Fig 15-1).

No expansive soils are found on the site.

In the southwestern United States, the largest area of sand dunes is actually not in the deserts, but in the Colorado Plateau region, centered on the four corners area. Sand supplies here are abundant from both sandstone bedrock and dry river channels. In this area winds capable of moving sand are dominantly from the southwest (Fig 15-2). Compared to desert areas around the world where large sand seas are found, the Colorado Plateau has winds capable of moving sand (*drift potential*) that are very similar. These periods of drift potential are more likely to occur during extended periods of drought and circumstances derived from overgrazing.

Page's close proximity to the Navajo Reservation, where large areas of grazing occur, may subject the area to this drift potential of the sand. Design considerations will be made to correct problems that may occur as a result to this situation.

Physiography

Slopes of 20% or greater common on periphery of Manson Mesa (Fig 16-1). The development of these areas have been of the recreational nature and highly restrictive. Preservation of existing natural conditions has been a primary objective of the community, with a nature trail and bike path constructed around the perimeter (Fig 16-2).

As an addition to this trail, the Institute will be joined by a branch through the business district and government area of Page. The trail will also link the Institute's planned Landscape Demonstration garden and the high school adjacent to the City Park.

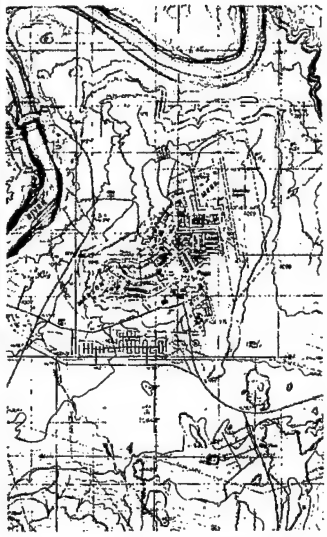


Figure 16-1: Slopes of 20% or greater common on Mesa periphery.

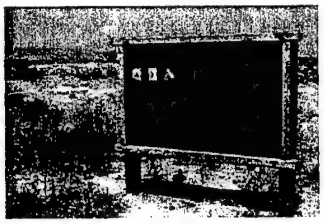


Figure 16-2: Nature trail and bike path trailhead.

Figure 17-1: Floodgates opened at Glen Canyon Dam during high water mark in 1982.

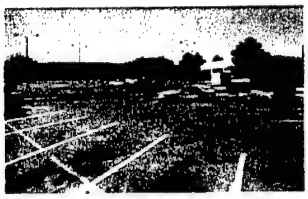


Figure 17-2: Page Plaza and surface lot with 4% grade.

Figure 17-3: Glen Canyon and the Colorado River, below the dam.

Hydrology

The Institute's Project Site is Page Plaza, on the intersection of Elm Street and Lake Powell Boulevard. The slope of the site is 4% (Fig 17-2). Page is generally located on the west side of Antelope Canyon in Northern Cococino County, Arizona. The surrounding area is bisected by several small washes, including Honey Draw and Antelope Canyon, and several smaller and unnamed branches -- all flowing north-northwest into Lake Powell and the Colorado River/Glen Canyon (Fig 17-3).

STORMS
Summer precipitation is frequently associated with thunderstorm activity, which begins mid-July to mid-August, reaches a peak of 5 to 10 thunderstorms each month in midsummer and ends in the early fall.

The maximum amount of precipitation recorded in 24 hour period of time are as follows:
- snow = 4.3 inches (Jan)
- rain = 0.61 inch (July)

Records indicate the following precipitation probabilities:
- 0.3 inch in 1 hour can be expected every 2 years
- 0.5 inch in 1 hour in every 5 years
- 2.0 inches in 1 hour in every 25 years

The site's elevation and location on Manson Mesa negates the possibility for flooding.

Flora

Adapted from USDA (1968) Soil Survey of Cococino County, Arizona

Rh - Riverwash
Capability unit VIIIw-1; not in a woodland group.

Ro - Rock outcrop
Capability unit VIIIs-1; not in a woodland group.

Vegetational zones are conspicuous but lack uniformity. In the lowest zone, there are arid grasslands, but sod seldom covers the ground completely, leaving many bare areas. Arid climate shrubs often grow in open stands among the grasses, and sagebrush is dominant over extensive areas. A profusion of annuals and perennials blooms during the summer rainy season. At low elevations in the south, several kinds of cactus and yucca are common. Cottonwoods, mesquite, and other trees grow along some of the permanent streams (Fig 18-2).

Grazing has had a substantial impact on the native flora of the region surrounding Page. Overgrazing has occurred in some areas on both public lands and the reservations, where the wool industry and sheep have had a traditional role in the Native American culture.

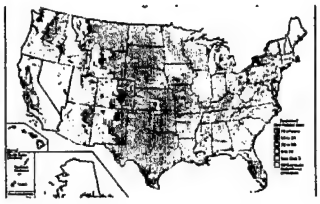


Figure 18-1: Map showing sparsely vegetated Southwest.

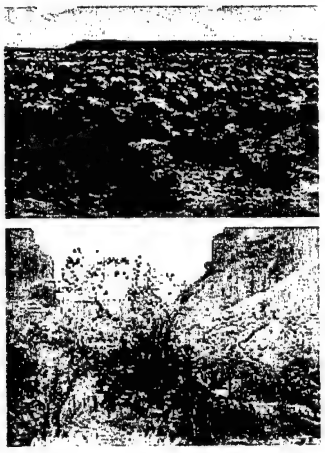


Figure 18-2: Arid grasslands and the common mojave Mesquite are found throughout the Colorado Plateau.

Figures 19-1: Grazing on both public land and reservations have impacted native fauna and flora.

Figures 19-2: Many reptiles are found in the area, including the infamous rattlesnake.

Fauna

The wildlife population Cococino County formerly included elk, deer, bear, cougar, coyotes, wolves, whitetailed rabbit, cottontail rabbit, lizards, snakes (Fig 19-2), waterfowl, California condor and grouse.

At present, deer, coyotes, rabbits and other small rodents are scattered throughout the county but are most numerous in the mountainous foothills of the San Francisco mountains and the Kaibab National Forest . There are no elk or wolves in the county now. Bear, cougar, and grouse are confined to the timbered areas. Waterfoul live along Lake Powell and streams and lakes and in fresh-water marshes.

California condors have been introduced. These birds are most abundant along protected areas of the North Rim and Vermilion Cliffs areas. They have adapted but are few in number.

The Navajo Reservation has large amounts of grazing sheep, goat, and cattle herds. Wild horses are also abundant on reservation lands. Public lands of the Bureau of Land Management and other federal lands also permit grazing in permitted range areas.

Human Culture

There are several valuable archeological and historical locations in the surrounding region. Antelope Canyon is a Navajo Tribal Park, and the corkscrew canyon is the site of Native American artifacts indicating it was used extensively as a shelter for nomatic people. The cave also contains a unique and scientifically critical geologic formations.

The canyonlands of the surrounding plateau country is also the location of numerous documented and undocumented Native American ruins. Petroglyphs are also found in many areas, and are protected by federal law. This area was once home to the Anasazi tribe, thought to have habitated the region between 600 to 1400 years ago (Fig 20-1).

Rainbow Bridge National Monument, the world's largest natural bridge, was discovered on 14 Aug, 1909 and can be reached today by boat on Lake Powell or overland trails on the Navajo Reservation.

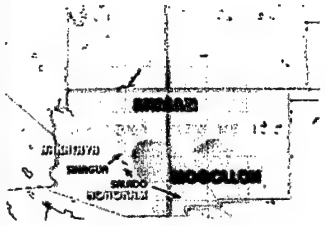


Figure 20-1: Anastazi peoples of the Southwest.

Figure 20-2: Formations near Antelope Canyon Tribal Park.

Figure 20-3: Traditional nomadic Navajo hoogans.

Colorado Plateau Institute

United States Department of Interior

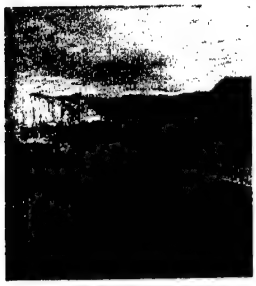


Figure 21-1: Views of Lake Powell

Figure 7-2: Corkscrew canyons in the Glen Canyon National Recreational Area.

Institute Program

The following information will outline the specifics of the Colorado Plateau Institute program, codes and standards that apply, and the desired result for the people of the city of Page.

Principle Land Uses Permitted:
The site for the proposed Institute contains approximately 33,000 SF of existing space, with on site parking. The area is zoned as DB (downtown business) and is adjacent to Memorial Park and multi-use area and the Downtown Pedestrian Pathway (Fig 23-1).

General Institute Vision:
As stated in the Mission Statement, The Institute will, "develop and enhance water resource management and conservation methods through research and educational programs." Through federal and private programs, the Institute will help to facilitate this mission. In return, Page will ensure the continued beauty and attraction of the Colorado Plateau country.

As part of the program, the Institute will be able to contract up to two research initiatives or agencies concurrently. The DOI will have two employees permanently located at the Institute. One position will be Facility and Program Manager, the second is a Maintenance Engineer.

The facility will provide permanent laboratory and educational facilities for centralized control of agency research programs. As the emphasis of research activities change, reflecting the emergence of promising new areas of inquiry, the facility must be able to meet the demands for new tools, equipment, and techniques with which to address water-resource issues.

DB Zoning:
As stated in the General Plan, "The DB category shall provide for the development of the downtown area as the center of the community. The DB category shall encourage year-round commercial, entertainment, cultural, recreational, office, and civic activities. The DB category shall allow eating and drinking establishments, professional offices, government administration uses, specialty retail, galleries, and tourism related retail and lodging. Commercial services for adjacent residential neighborhoods shall also be permitted."

Development standards state a maximum FAR of 0.30 in DB zoned areas. Maximum building height of two stories. Characteristics should include uses which create a unique, dynamic pedestrian oriented center in downtown Page.

Neighborhood Commercial Center:
The site is located adjacent to an existing community market and shopping center. This area is also zoned as DB.

Memorial Park:
The park is an open zoned public space south-southeast of the site. The area is landscaped with multi-use courts and public facilities. The Page Town Hall forum has recommended the construction of a youth center in Memorial Park.

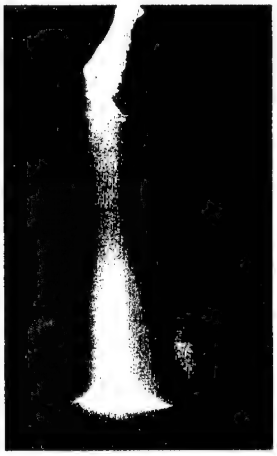


Figure 22-1: Sunlight in the corkscrew canyons

Figure 22-2: Example of space in the narrow sandstone canyons.

Figure 23-1: The downtown Page Pedestrian Pathway.

Government Guidelines:
A criteria for evaluating the final proposal will be the compliance to all standards and guidelines established under the Department of Defense (DoD) Facility Requirements System. As a facility that will be utilized by government employees, specific laws and regulations will have to be met. Air Force Instruction 32-1084 establishes the Institute as category group 17: Training Facility. Other type codes that apply are:

1. 171-621 Technical Training Classroom
2. 171-623 Technical Training Laboratory/Shop
3. 171-627 Technical Training Support

These category codes will help to facilitate further programming requirements and facility space allowance guidance.

Laboratory Guidelines:
The laboratories will generally be contracted as a controlled environment laboratory. A controlled environment room is a laboratory in which temperatures and humidity are maintained within a specified range so that laboratory activities can be conducted and products maintained under controlled conditions. These spaces are frequently used for conducting activities normally performed in a general chemistry or biology laboratory.

The laboratory and research areas are a special concern for safety, as they are high hazard areas that use flammable, toxic, and pathogenic materials or processes.

The laboratory building population will not exceed 10 persons per bay. The areas will generally be staging areas, with flexible workstations and emergency response stations in each laboratory.

Waste removal and recycling area will be a shared support space.

Mechanical services to the laboratory and research areas should be isolated from the other building functions. Controlled temperature, humidity, and air changes will be maintained in each individual laboratory. One laboratory will contain specialized filtration and exhaust equipment, including supply and local exhaust, fume hoods, and biosafety cabinets.

Normal electrical power will be supplied. Emergency generator backup will be available.

Telephone, data, and security alarms will be closed circuit systems in each individual laboratory.

Generic laboratory modules, structural systems, building enclosure systems, and emergency egress will comply with OSHA, NFPA, ADA, and BOCA codes, as well as all local and state laws and ordinances.

Additional Guidelines:
The Institute will also provide the city of Page with additional public meeting space, to be programmed as a 225 seat auditorium.

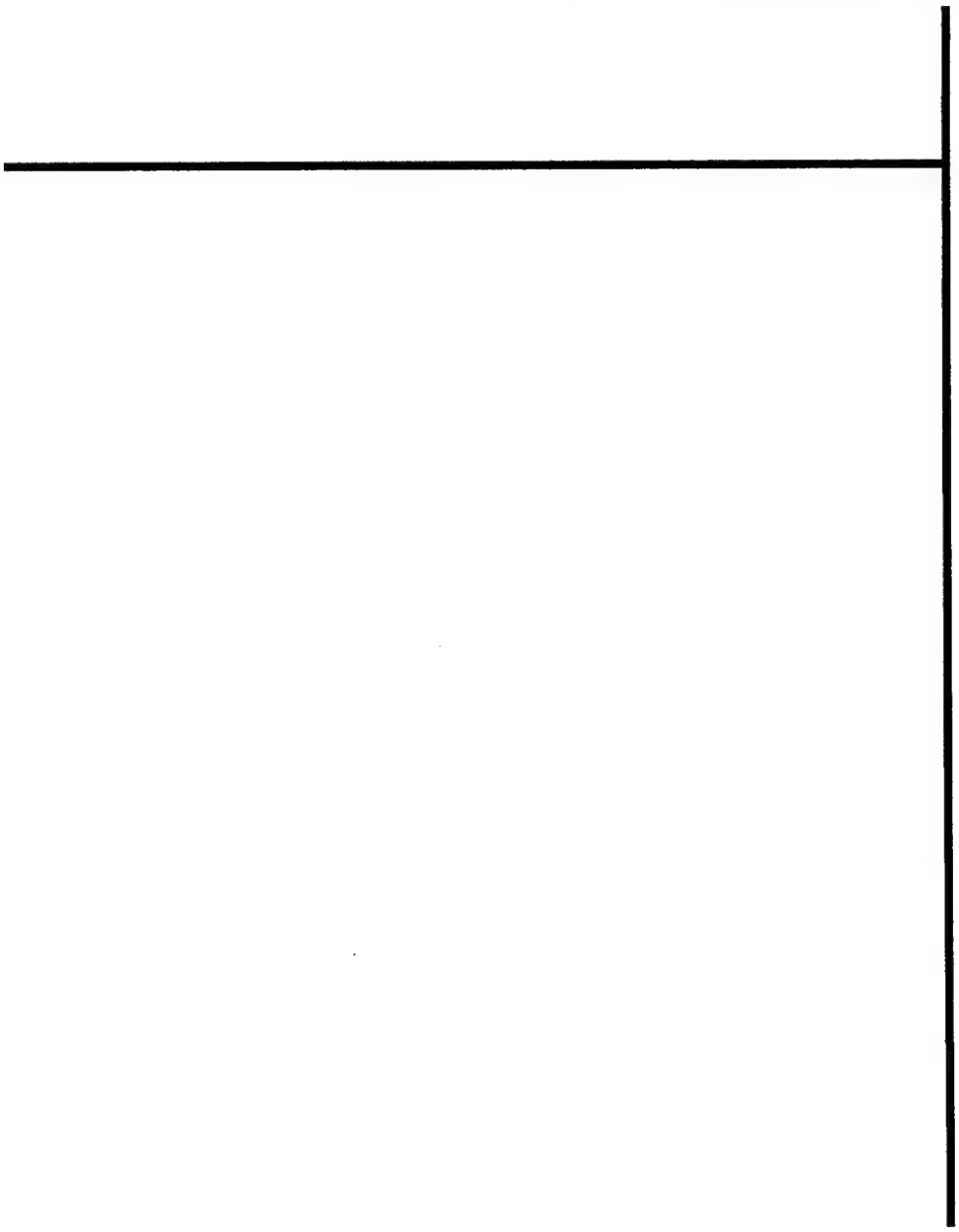
The distance learning center will be equipped with video conferencing equipment to facilitate laboratory and field technicians that are instructing or relaying visual information to classrooms or a central control facility.

The recycling program for the city of Page will also be administered from the Institute. A centralized recycling point will also help to foster community awareness and generate support from localized downtown businesses.

The Institute's mission is founded on the principles of sustainable design and development in the desert environment. Therefore, the final design submission will include new sustainable technologies and systems that will enable the Institute to reduce energy and water consumption where feasable. Final submission will include specifications from the AIA Environmental Resource Guide and GreenSpecs, and a LEED (Leadership in Energy and Environmental Design) certified rating on the final building (26-32 points minimum).

LEED Certification Review Process:

1. Application Submittal
2. Administrative Review
3. Technical Review
4. Award
5. Schedule



Colorado Plateau Institute

United States Department of Interior

Spatial Program

Zone I : Research

Adaptive Management Work Group 2,600

Work Group Conference (1 @ 800 SF)
Conference space is secure area for program administration and planning. Also provides controlled access between laboratories and public-access areas of the Institute. Also provides secure storage for sensitive or high-value equipment. Computerized workstations that include scanner, printer, and LAN file server network connections will be located in this area as well.

United States Geological Survey (1 @ 300 SF)
Bureau of Reclamation (1 @ 300 SF)
National Park Service (1 @ 300 SF)
Bureau of Land Management (1 @ 300 SF)
Bureau of Indian Affairs (1 @ 300 SF)
Fish and Wildlife Service (1 @ 300 SF)

Laboratory and Field Research: 13,860

Water Science Laboratory (1 @ 6,000 SF)
High-bay area for staging Colorado River and impoundment research initiatives. Controlled environment for temperature, humidity and dust. Uses include sedimentation calibration, automated censures, core sampling, water quality analysis, etc. Use of both reagents and organic compounds, and inert, non-toxic chemicals is expected. Laboratory area is to be open plan, flexible space that facilitates a variety of functions and specialties. Two (2) fume hoods per laboratory. 110/208/220 electrical supply. Eye-wash and emergency showers in all laboratories.

Colorado Plateau Field Station Laboratory (1 @ 6,000 SF)
Extension of the Department of Interiors's Biological Resources Division (BSD) at the University of Northern Arizona, research will be conducted on the management and conservation of indigenous species endangered by the effects of the impoundment of the Colorado River.

Cold Storage (2 @ 30 SF)
Refrigerated storage for suspending samples and preserving organic tissue samples for future analysis.

HMAT storage (8 @ 75 SF)

Controlled storage of toxic materials; salts, dyes, acids, bases, reagents, organic compounds and wastes. This space will be a single purpose area; of non-combustible construction; one-story in height without basement or crawl space. To conform to hazardous material storage requirements it is recommended that eight separate storage areas be used; reuse-reutilization, flammable, corrosive, reactive, oxidizer, poison, acid, and combustible.

Materials Library (1 @ 1200 SF)
Area for contingency tooling, excess storage, collection samples, program demonstration and exhibits. Also includes workshop and facility equipment storage.

Wash rack (1@ 300 SF)

Loading Dock (1 @ 1000 SF)

Subtotal **17,760**

Zone II : Demonstration/Public

Department of Interior 12,600
Teleconference center (12 people)(1 @ 525 SF)
Resource area to accommodate both research and community programs, with an emphasis on instructing or relaying visual information to the classroom or central control laboratory. The teleconference center will have rear-screen projection television with video conference capabilities, securable storage for high-value equipment, and adequate shelving for audiovisual tapes, supplies, etc. Additional equipment usually includes video projectors, cameras, computers, CCTV capability, wireless microphones, and speakers.

Page Community Investment Program
Auditorium (200 people)(1 @ 3,400 SF)
Public auditorium that provides the community with public meeting space. Auditorium will also support Coconino Community College lecture and teaching requirements. Furnished with either fixed armchairs or sets of chair and narrow tables. Chairs should be tiered and adequate aisle space maintained.

Projection booth (1 @ 400 SF)
Projection booth for auditorium should be soundproof, with space available for standard equipment and space for software storage and equipment maintenance. Standard 60 cycle, 120 watt power source for operating multi-media to be supplied.

Public Outreach Network and Clearinghouse
Providing information to Federal, State and tribal agencies and the general public on environmental research and impact studies focused on Colorado Plateau ecosystems. Access to the Colorado Plateau Field Station (USGS) Geographic Information System (GIS) located in Flagstaff, AZ will be located at this public workstation.

Exhibit area 7,000
Main circulation space for the Institute. Gallery for public display of Institute research and displays pertaining to issues critical to the Colorado Plateau.

Recycling center 350
Centralized collection and sorting point for community recycling program. Area will be easily accessible to the public to foster community awareness and support.

Subtotal **18,675**

Zone III : Administration/Support

Reception 150
Public access area representing the facility's primary user. Administrative space will allow for an equipment area for desktop computers, printers, facsimile, and various filing and storage cabinets. A reception lobby and waiting area for visitors will also be located in this area.

Administration Offices:

Facility Director 280
A separate and private office for the Director. The nature of operations dictates a private space of sufficient size for small group work and meeting space.

Maintenance Engineer 150
A separate and private office for the maintenance engineer. Space may be in close proximity to mechanical or tool storage areas in the facility.

Laboratory Services Area (joint use) 275
Private lounge space for laboratory technicians. Area should be centrally located to all laboratories, and provide vending and seating area.

Lounge (25% area of Auditorium) 850
Lounge area should provide a comfortable, attractive setting for student interaction and break area. The space should include a sink, refrigerator, and microwaves. It should also be wired for television and provide space for limited seating.

Public restrooms 1200
Adequate restrooms will be available to accommodate an auditorium with a 200 seat capacity, in addition to facility requirements for a maximum capacity of 108 persons.

Storage 1,200
Space for storage of administration supplies, training aids, classroom equipment, tools, and other miscellaneous items.

Janitor 400
Area to accommodate janitorial staff. Storage of cleaning and maintenance products, in a central and efficient location.

Subtotal	**4,505**
Natural Draft Cooling Tower(s) Approximate dimensions: 25' x 25' (to be determined by manufacturer's specifications.	1,250
Mechanical footprint (20% of gross)	8,400
Total Area (SF)	**51,620**

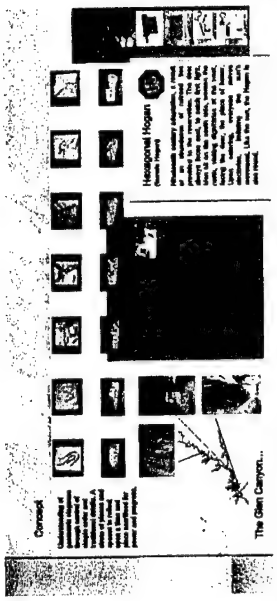


Figure 31-1: Conceptual design presentation board

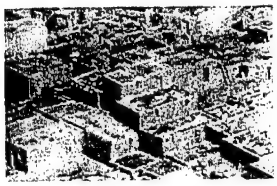


Figure 31-2: Pueblo dwellings in the Southwest

Conceptual Design

The essence of the Institute was the canyon and river that it is designed to preserve. Remembering the glens and grottos that were submerged under the waters behind Glen Canyon Dam is a key concept of the forms generated for the Institute.

Also lost beneath the waters of Lake Powell are hundreds of sites containing examples of Anastazi art and culture. The development of these ancient people along the shores of the Colorado River occurred over the last thousand years. Evidence of their existence still remain, and their Hopi and Pueblo decendants carry on some of the traditions. Thriving in the harsh and austere environment of the Southwest, these cultures have generated structures and methods that conform with the climate, and an important concept in the design of the Institute.

Major Powell's expedition of the Colorado River in 1869 documented the Glen Canyon for the first time. In his journal, Major Powell gave us detailed descriptions of some of the most beautiful places found on earth. Three of these places were picked to represent the canyon that has been lost beneath the reservoir that bears his name; Tapestry Wall, Music Temple, and Labyrinth Canyon (Fig 32-1).

In the design of the Institute, it is essential to recreate, in architectural form, the feeling that these spaces transgressed on its visitors.

A conceptual presentation was held on 30 Oct, 2002. Issues openly discussed were southwestern cultures, Glen Canyon as the birth of the conservation movement, site context, tourism and local economic conditions, and the importance of water in the southwest. Major criticisms established was the lack of clarity in the mission of the laboratory, how water can be integrated into the design of the Institute, and use of flowing spaces and curvature in the design.

The jury consisted of five members. Representing the College of Architecture were Dean Wayne Drummond, Dr. Sharon Baum-Kuska, and Patricia Morgado; Dr. N. Brito Mutunayagam of the College of Community and Regional Planning; and Dr. Daniel Snow of the Water Sciences Laboratory, Institute of Agriculture and Natural Resources.

Figure 32-1:

Photographs of the Tapestry Wall, Music Temple, and Labyrinth Canyon, now submerged beneath Lake Powell.

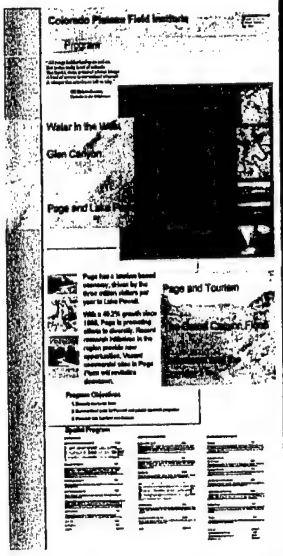


Figure 33-1: Schematic design presentation board

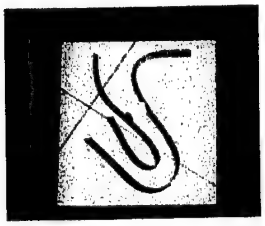


Figure 33-2: Conceptual design model

Schematic Design

"All things hidden lead us on and on.
But in this rocky heart of solitude
The fearful, deep, primeval silence brings
A kind of answer to our wither? whence?
A whisper that can almost tell us why."

Cid Ricketts Sumner,
Traveler in the Wilderness

Program and schematic design development was presented on 19 Dec 2002. The presentation included a series of patterns and forms, as well as a spatial program and schematic floor plan. Site conditions were again reexamined, and a Colorado Plateau Institute mission was established.

Criticisms of the jury included how the flowing forms and spaces interacted with the site, views from the structure, pedestrian approaches from the schools and downtown areas of Page, and concerns with the clarity of the Institute's program and mission.

From this critique, the program was thoroughly scrutinized and evaluated on specific laboratory functions. The exact type of research was determined to be for the United States Department of Interior's (DOI) Adaptive Management Program.

The Adaptive Management Program was established by the DOI in 1996 to study and assess Glen Canyon Dam's effect on downstream resources and to make recommendations for dam operations that will protect those resources. Studies include sedimentation and sand bar erosion in the Colorado River, methods of sediment transfer and downstream transport, endangered species protection and monitoring, and other regional surveys.

Interaction with pedestrian visitors to the Institute's exhibits and lectures were also examined. Many methods were examined, including patterns that exist with the Salk Institute in San Diego, CA and LUMCON Research Center on the Mississippi River delta and Soda Springs Desert Study Center in Baker, CA.

This stage in the process also demonstrated the major importance of design integration of shading and cooling methods and technologies. Use of cooling towers, photovoltaics, building orientation, site manipulation, and other methods were identified during this stage.

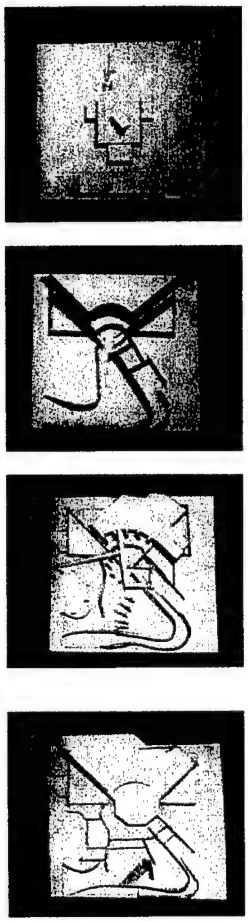
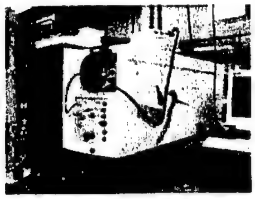
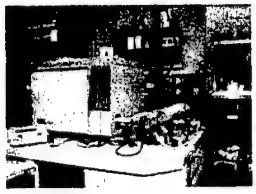


Figure 34-1: Schematic design models

Colorado Plateau Institute

United States Department of Interior





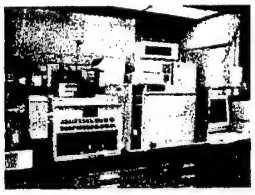


Figure 35-1: Examples of laboratory equipment

Design Development

Research of flowing form and spaces, pedestrian approaches and courtyard/plaza design fundamentally impacted the form and aesthetic representation of the Institute. Various relationships were also manipulated throughout this stage. Public and private spaces, mechanical and laboratory arrangements, existing and new construction, and the use of water in a desert environment were just a few of the major issues.

Equipment and other critical issues concerning laboratory facility design were established. Emergency egress, movement and arrangement of equipment, scientist office and support areas were identified.

Laboratory Equipment examples:

Mass spectrometer Instrumentation*

Voyager DE-STR Linear or reflector mass analysis

Quattro LC Tandem quadrupole mass spectrometer

Platform LCZ Single quadrupole mass spectrometer

VG TRIO 2000 Research grade single quadrupole mass analyzer, using ionization methods*State University of New York, Mass Spectrometer Facility, www.pharm.sunysb.edu

Agilent Benchtop single quadrupole mass spectrometer

*State University of New York, Mass Spectrometer Facility, www.pharm.sunysb.edu

Passive Cooling
The primary comfort strategies in overheated climates are defensive. They avoid gains due to solar radiation through shading and reflective barriers and heat transfer through the envelope. Passive cooling requires the evacuation of heat from the building to the sky and earth.
Evaporative cooling is the process of intentionally wetting building components while exposing them to airflow. This strategy is the most effective in dry, arid climates.

Acoma
Massive, multi-story adobe construction. Up to three feet thick, mud walls provides tremendous thermal storage capacity. Window openings were few and deeply recessed to protect from the intense heat. Each successive story was set back to provide terraces on the roofs of the story below, with the profile facing south.

Sunspace
Passive solar heating provides for sunspaces to be oriented due south.

Courtyards
The roof can be designed to enhance the cooling cycle in courtyards. If the roof surrounding the courtyard is sloped towards the courtyard, as the roof cools at night, the layer of air above the roof becomes more dense, and drains into the courtyard.

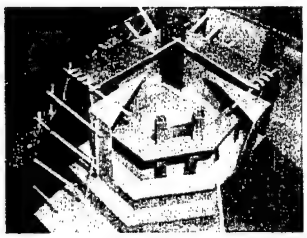
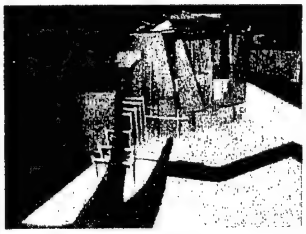


Figure 36-1: Design development model



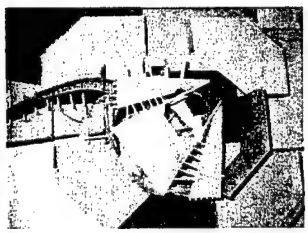


Figure 36-2: Design development models showing roof and facade

Final Proposal

The following drawings are the final proposal for the new United States Department of Interior Colorado Plateau Institute, for Page, Arizona.

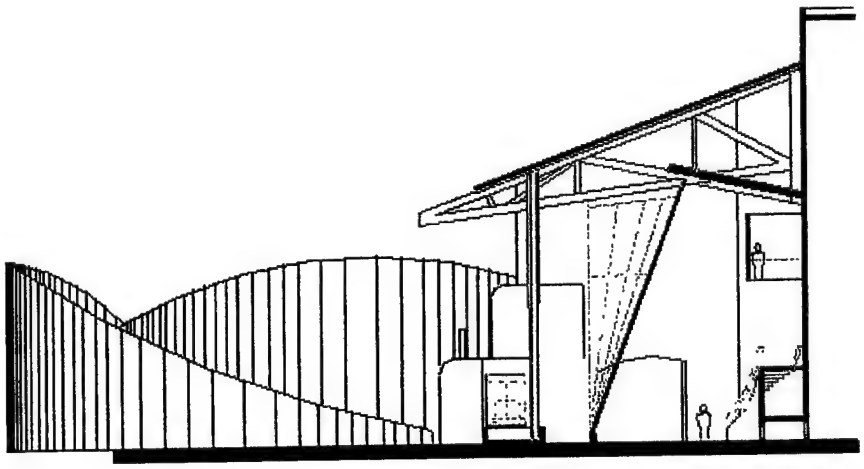
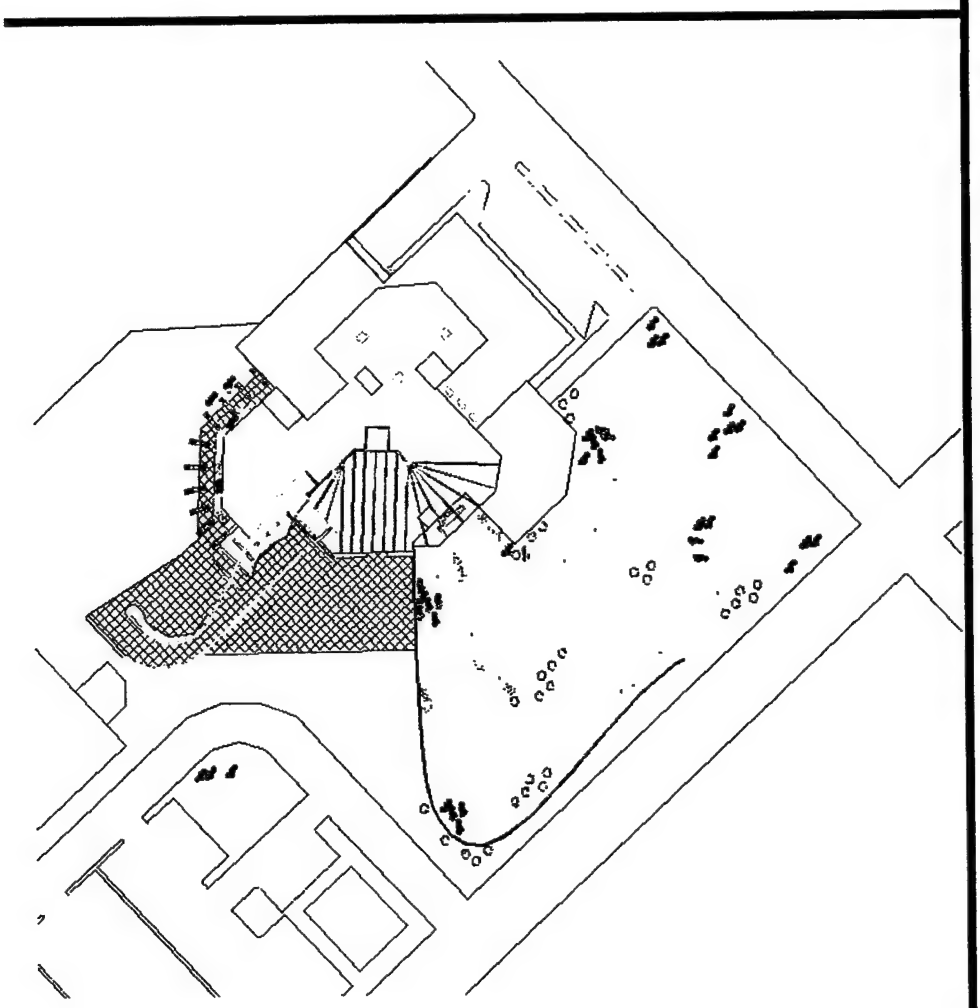


Figure 37-1: Section through exhibit and circulation area



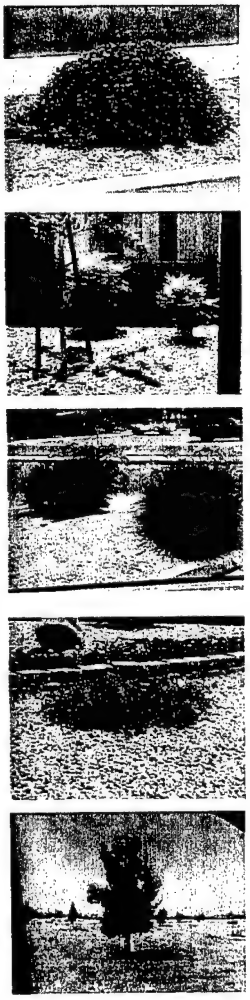
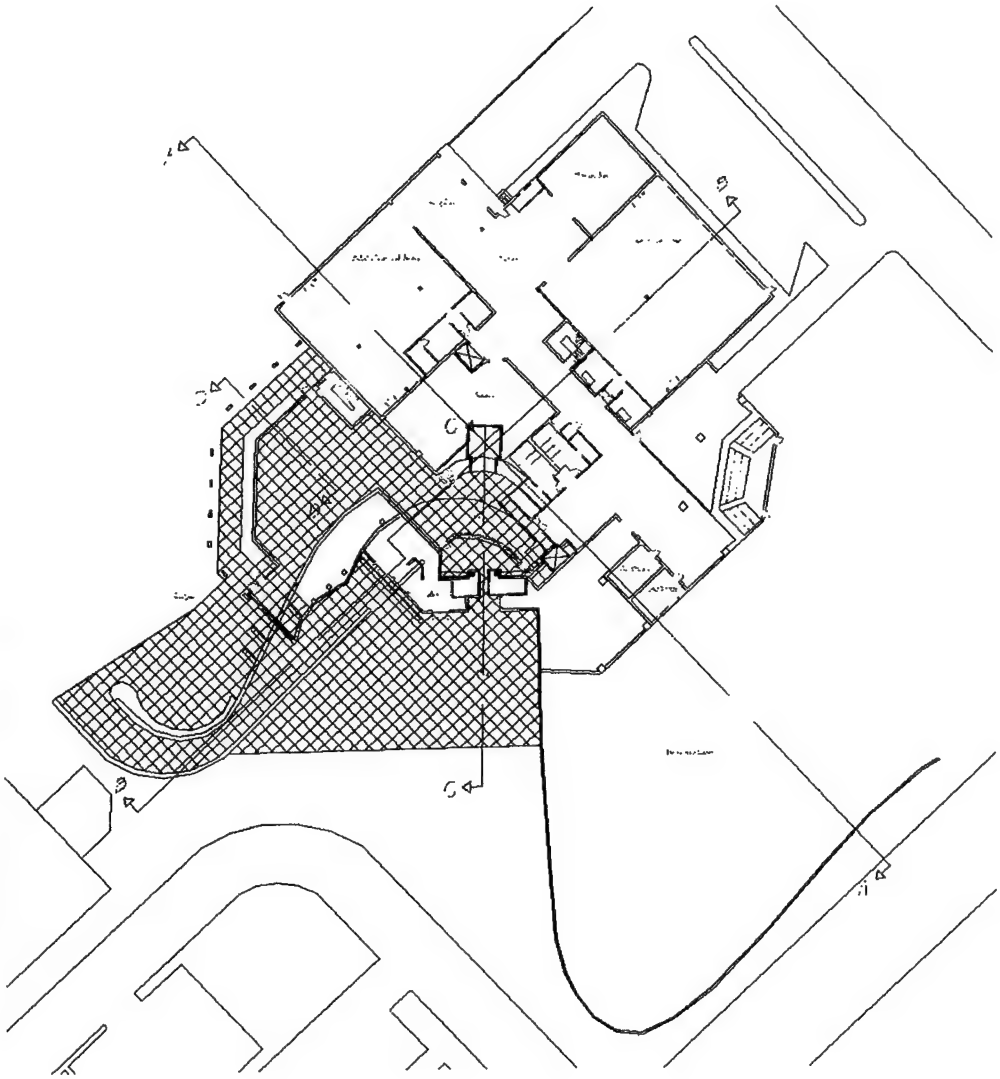


Figure 38-1:
Landscape plan of site

Figure 39-1: First floor plan



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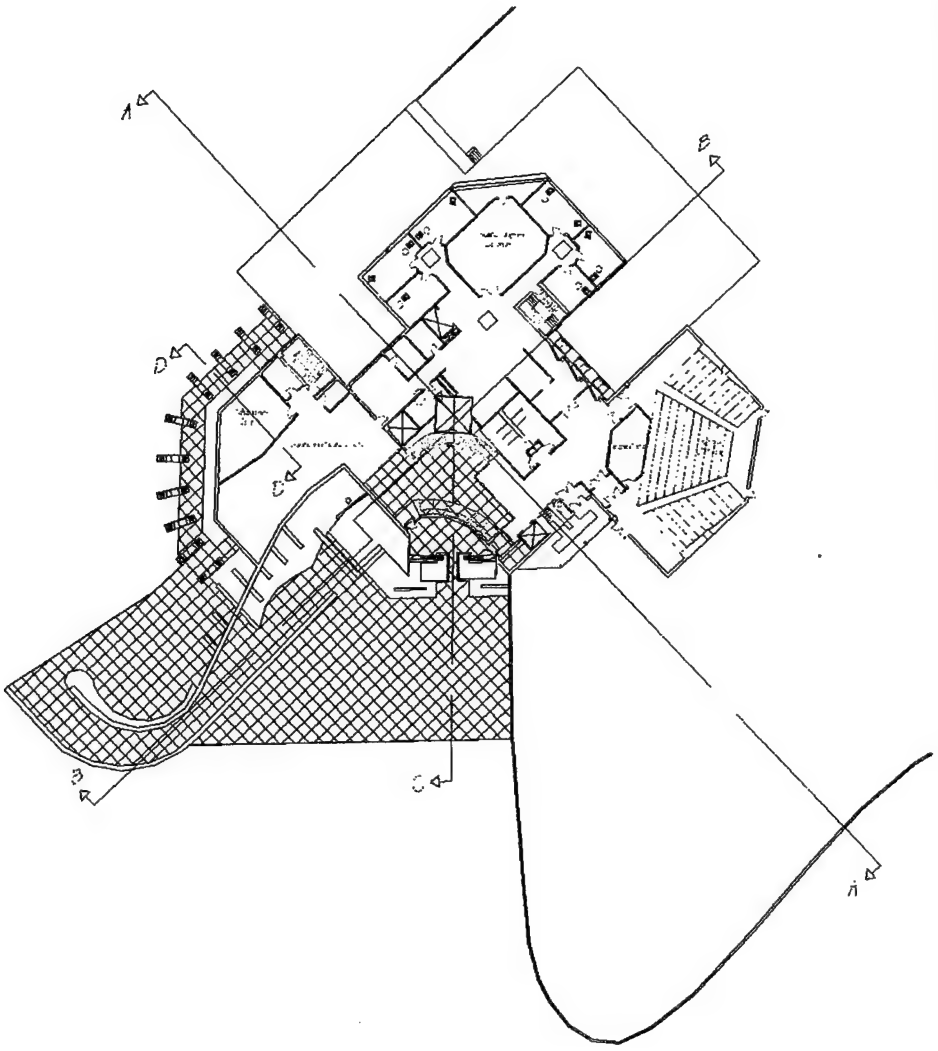
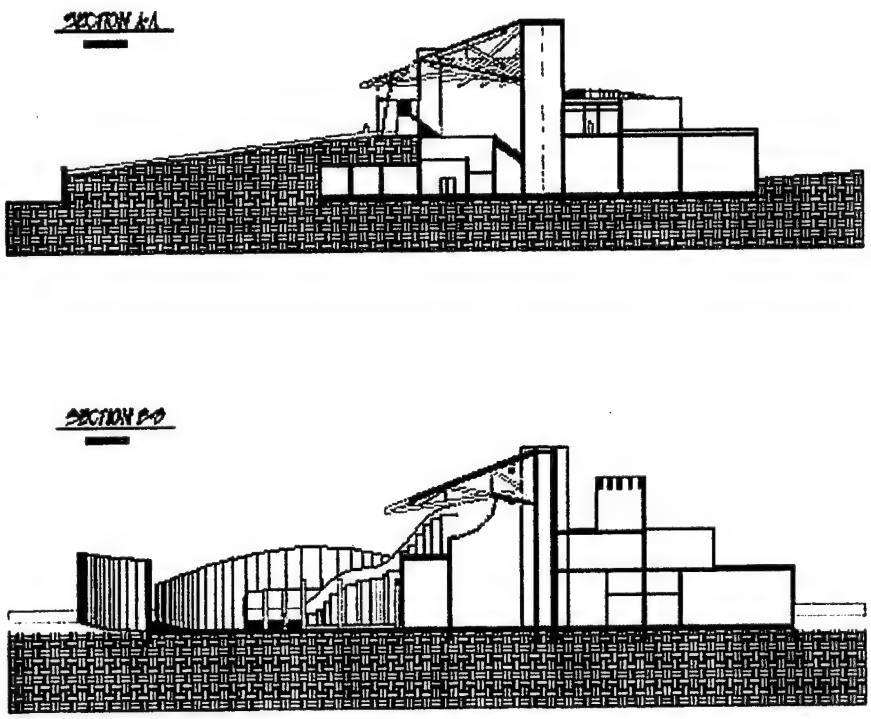


Figure 40-1: Second floor plan

N

NTS

Figure 41-1: Sections A-A and Section B-B



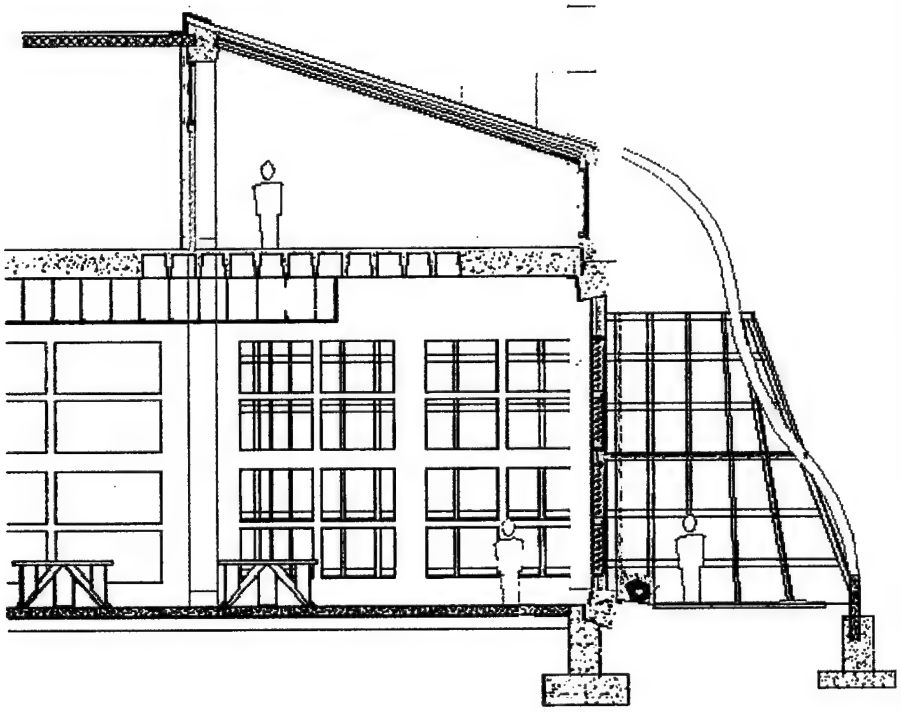
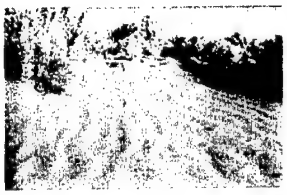


Figure 42-1: Section-Detail D-D through lounge and exhibit areas

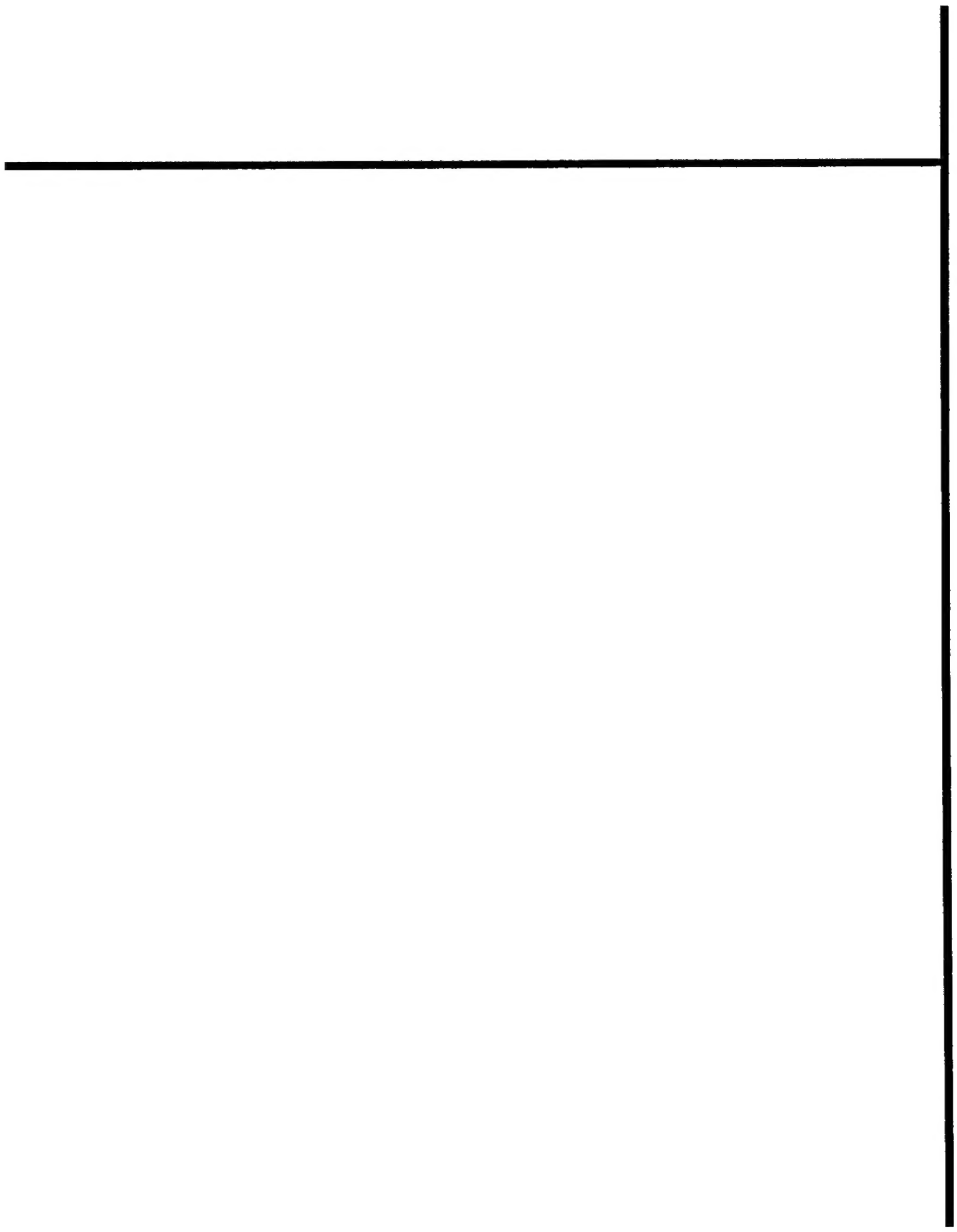


Conclusion

The architectural proposal developed from this program will be an in-depth application of new sustainable applications in proven laboratory design. In addition, the reuse of an existing facility will help to revitalize and enhance a downtown community. The completion of the project provides a model for instructing numerous Air Force and civilian architects and engineers to be applied on military installations across the United States.

As the Southwestern United States continues it pace of rapid development, the Colorado River's fame may not stem from its colorful canyons or raging rapids, but rather from its decimation and overuse. As the environmentalist Marc Reisner stated, "The Nile is the only other river in the world where so many people are so helplessly dependent on one river's flow." (Marc Reisner, Cadillac Desert, pg. 120-21) The hand of human development can be heavy, but it does not have to be destructive.

A laboratory dedicated to reversing the negative results of public works projects will be a monument to the survival of nature's delicate ecosystems. With government and private industry working together in the same building, in the shadow of the greatest monument of man's destructive engineering power, will help to redefine the environmental movement in the United States.



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List of Resources

Leadership in Energy and Environmental Design (LEED) Rating System

BREEAM/Greenleaf environmental assessment methodology

AIA Environmental Resource Guide and GreenSpecs

Hannover Principles adopted by the International Union of Architects (UIA)

Executive Orders 12873, 12902, and 13101

Comprehensive Procurement Guidelines (CPG) established by the EPA

Federal Acquisitions Regulations (FAR) 36.602-1

Air Force Environmentally Responsible Facilities Guide

US Energy Policy Act of 1992 (EPACT)

Karen Kivela, "Implementing Sustainable Construction Practices," www.afcee.brooks.af.mil/green/resources.

Of special note:
City of Page General Plan Update (March 1996)
Air Force Environmentally Responsible Facilities Guide
Air Force Instruction 32-1084: Facility Requirements System